Kinematic analysis of a new running shoe concept based on a biomimetic approach, the floating heel running shoe

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Introduction

Some studies suggest that current **conventional running shoes facilitate a rear-foot strike running technique** (1) which is associated with **higher impact forces** (2), **higher overstride length (OVL)** (figure 2) (3) **and higher braking forces** (4); moreover, **it limits harnessing the elastic energy stored in the Achilles tendon** and calf muscles during push-off (5). As a result, the running technique encouraged by to conventional shoes may be associated with overuse injuries related to impact (6) and lower running economy (5).

A new concept, called **FBR** (Faster and Better Runners) (patent Nº EP3061361 A4) (figure 1), based on a **biomimetic approach aims to mimic kangaroo and ostrich feet.** Both animals have a common factor: **the floating heel,** that allows them to take advantage of the elastic energy of the lower limb muscles-tendon units (7). FBR consists of a running shoe with similar midfoot and forefoot features to conventional designs, but without the midsole under the heel, in order to allow a free vertical movement of the heel without any ground contact during stance, thus taking advantage of the elastic energy provided by plantar flexor muscles. **Previous studies conclude that FBR promotes a midfoot strike pattern and reduces the impact transient** (8); however, no study has proved the effects on the OVL or the heel vertical movement.

Objective

The objective of this study was to investigate the kinematic differences between running in conventional shoes (CVN) and the FBR; specific variables were: the landing technique (Foot strike angle, FSA), OVL and heel vertical movement (HVM) during stance phase.

Figure 1. FBR concept

Method

FAMILIARIZATION PHASE

to the new shoe concept

15 injury-free recreation al runners

(3 WEEKS)

BIOMECHANICAL ANALYSIS

3D movement analysis
10 camera motion capture system (250 HZ). Following a short warm up, all participants performed 5 good running trials over a runway at their current 5km speed in the two footwear conditions (random order).

DATA ANALYSIS

Variables: Foot Strike Angle (9), Overstride length (figure 2), heel vertical movement (figure 3),

T – test paired samples ($p < 0.05$)

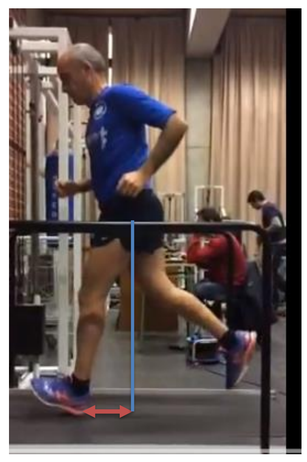


Figure 2. Overstride length (red arrow)

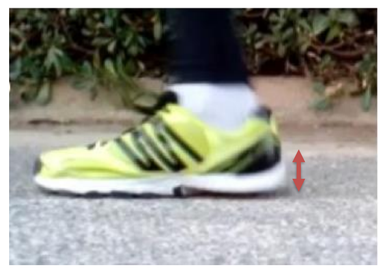


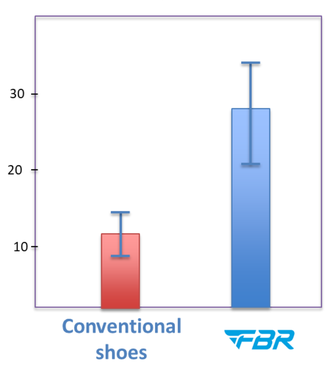
Figure 3. Heel vertical movement (red arrow)

Results

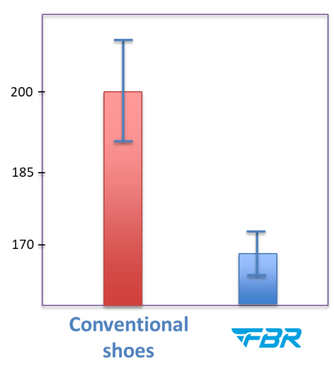
	FBR SHOES		CONVENTIONAL SHOES	
VARIABLE	MEAN	SD	MEAN	SD
Foot Strike angle (º)	3.8*	10.8	23.9	11.5
Overstride (mm)	166.1*	27.8	200.33	40.7
Heel vertical movement (mm)	27.6*	11.7	12.22	5.5

*** = Differences between FBR and conventional ($P < 0.05$)**

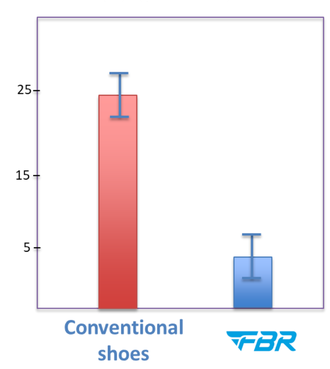
Heel vertical movement (mm) ($p<0.05$)



Overstride length (mm) ($p<0.05$)



Foot Strike Angle (º) ($p<0.05$)



Conclusions

The floating heel shoe has some potential advantages for injury prevention and sport performance compared to conventional shoes, such as: (1) it encourages running with a non-rearfoot strike pattern and (2) allows lower OVL and (3) higher heel vertical movement than conventional shoes.

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